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1 **In-situ surface preparation of InP-based semiconductors prior to di UVCVD silicon nitride deposition for passivation purposes**
How Kee Chun, L.S.; Courant, J.L.; Ossart, P.; Post, G.;
Indium Phosphide and Related Materials, 1996. IPRM '96., Eighth Internationa Conference on , 21-25 April 1996
Pages:412 - 415

[Abstract] [PDF Full-Text (316 KB)] **IEEE CNF**

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IN-SITU SURFACE PREPARATION OF InP-BASED SEMICONDUCTORS PRIOR TO DIRECT UVCVD SILICON NITRIDE DEPOSITION FOR PASSIVATION PURPOSES

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Introduction

To improve the passivation quality on InP and its related compounds, an in-situ soft pre-deposition surface preparation using an appropriate chemistry proves to be useful. Two different surface treatments prior to direct UV-assisted silicon nitride deposition have been tested, namely UV-excited ammonia gas and Xenon Difluoride vapour, and applied to InP, InGaAs and AlInAs semiconductors. To evaluate the influence of these two treatments on the electrical characteristics of III-V compounds, Metal Insulator Semiconductor (MIS) diodes were fabricated on InP and InGaAs and the interface trap density was deduced from C(V) analysis. As for AlInAs, simple Metal Semiconductor Metal (MSM) structures were fabricated and the level of surface leakage current was measured. From these measurements, both surface techniques turn out to be beneficial to the electrical characteristics of III-V semiconductors.

I. Device passivation

Passivation of semiconductor devices through the deposition of a dielectric layer is an indispensable step during technological processing. The role of the passivant as pointed out by Green and Spicer (1) is to isolate the semiconductor from the influence of the environment, thus preventing surface changes due to oxidation and contamination, and to hinder interfacial state formation in the band gap. Moreover, the dielectric must present a good potential barrier to charge carriers so that the carrier density within the structure may be preserved. Silicon devices are naturally very well passivated with the high quality SiO_2 layer, and this explains largely the success of silicon in commercial applications. On the other hand, for InP and its related compounds which have become attractive semiconductors for optoelectronic devices owing to their excellent transport properties and their compatibility to 1.3-1.55 µm communication systems, the passivation process is far from being simple and stands as a main challenge in device technology.

II. Direct UVCVD SiN_x deposition

III-V semiconductors notably InP and its lattice-matched ternary and quaternary compounds are known for their unstable surfaces due to the presence of dangling bonds, native oxides and contaminants. As such, to passivate these materials, three prerequisites must be met (fig. 1). In the first place, the insulator deposition process must be soft so as to preserve the surface and besides, the insulator film must be of excellent quality. We have therefore opted for direct UV-enhanced Chemical Vapour Deposition (UVCVD) method to deposit silicon nitride SiN_x which is known to be a damage-free technique as compared to conventional plasma and thermal deposition (2-4). Indeed, this technique permits a low temperature, ion-free deposition as the reaction energy is provided by incident UV photons.

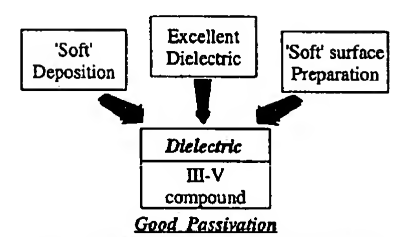

Fig. 1 : Three prerequesites for a successful passivation of III-V compounds

Our direct UVCVD reactor (fig. 2) deposits good quality bulk silicon nitride films as reported earlier (5). A 2. 10^{15} Ωcm resistivity and a 7 MV/cm breakdown were obtained for SiN_x films deposited on InP, Si and InGaAs substrates.

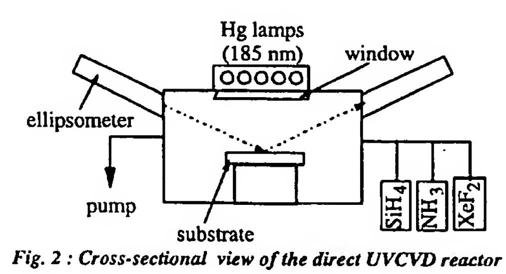

Fig. 2 : Cross-sectional view of the direct UVCVD reactor